

# Summary of results from GERB 1 & GERB 2 inter-comparison study

Funded by EUMETSAT

# Contents

- Aims of the inter-comparison
- GERB data products & availability
- Initial results -> updates
- LW inter-comparison results
- SW inter-comparison results
- Recommendations

# Inter-comparison Aims

- Supplement / enhance individual validation exercises undertaken for each instrument
- Investigate differences between GERB 1 & GERB 2, focussing on relative calibration not absolute accuracy
- Provide information to enable a single data record on a common scale (required for climate studies) → focussing on highest level products.

# GERB Data Products

- Level 2 Products:
  - **B**inned **A**veraged **R**ectified **G**eolocated (BARG)  
“Climate” product - unfiltered SW&LW radiance and flux  
Regular grid (VZA)  
PSF removed - 45km resolution (at nadir)  
15 minute resolution
  - **A**veraged **R**ectified **G**eolocated (ARG)  
Unfiltered SW&LW radiance and flux  
Regular grid (VZA)  
PSF not removed  
16.92 minute resolution (3 scan average)
- Level 1.5 Products:
  - **N**on **A**veraged **N**on **R**ectified **G**eolocated (NANRG)  
Filtered SW&TOTAL radiance  
Single image: TOT (0.3-500 $\mu$ m), SW (0.3-4.0 $\mu$ m)  
Image acquired ~3 minutes
- Level 0 Data (Non release data)
  - Raw data

# Current data availability

	<b>L2 BARG</b>	<b>L2 ARG</b>	<b>L1.5 NANRG</b>	<b>L0</b>
<b>GERB 2</b> (MSG1/ METEOSAT-8)	V003	<b>Edition 1</b> 25/03/04 → 10/05/07	<b>Edition 1</b> 25/03/04 → 10/05/07	N/A
<b>GERB 1</b> (MSG2/METEOSAT-9)	V005/6	<b>Edition 1</b> 01/05/07 → onward	<b>Edition 1</b> 01/05/07 → onward	N/A



Released



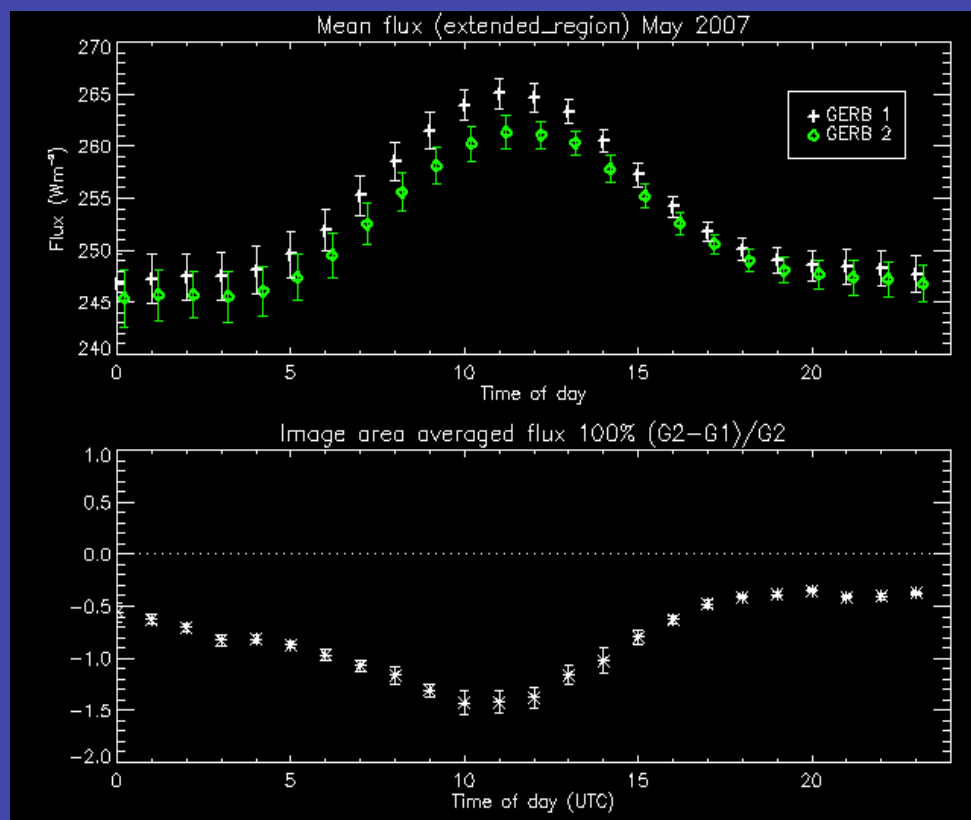
Release pending

# From GIST 29: L2 BARG LW Flux Diurnal (!) Variation

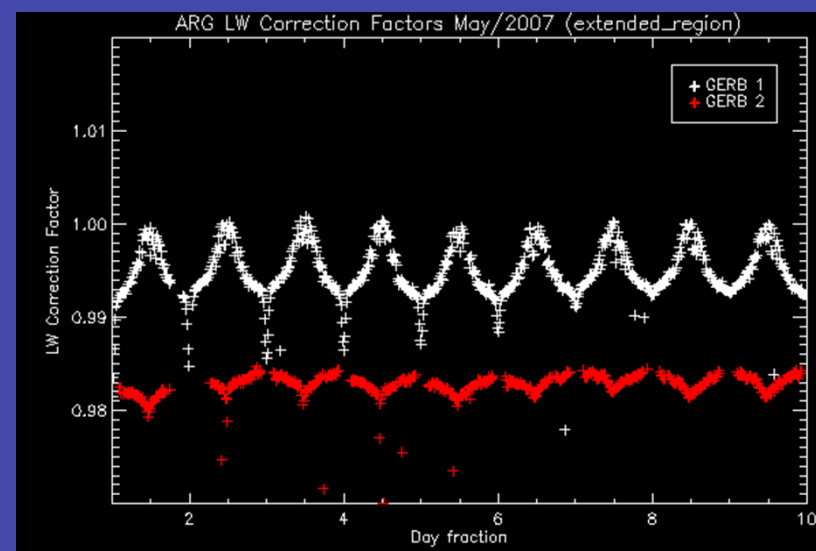
Scene type (clear sky)

	Ocean (clear sky)	Desert (clear sky)	Ocean (cloudy sky)
1200 UTC (2007)	-0.73 (0.24) G1=288.07 G2=285.97	-1.38 (0.55) G1=312.91 G2=308.73	-6.64 (2.40) G1=207.36 G2=194.63

Q. GERB 1 or 2 ?



GERB-1  $\sim 0^\circ\text{W}$ , GERB-2  $\sim 3.5^\circ\text{W}$   
 "Extended region":  $60^\circ\text{N/S}, 60^\circ\text{E/W}$

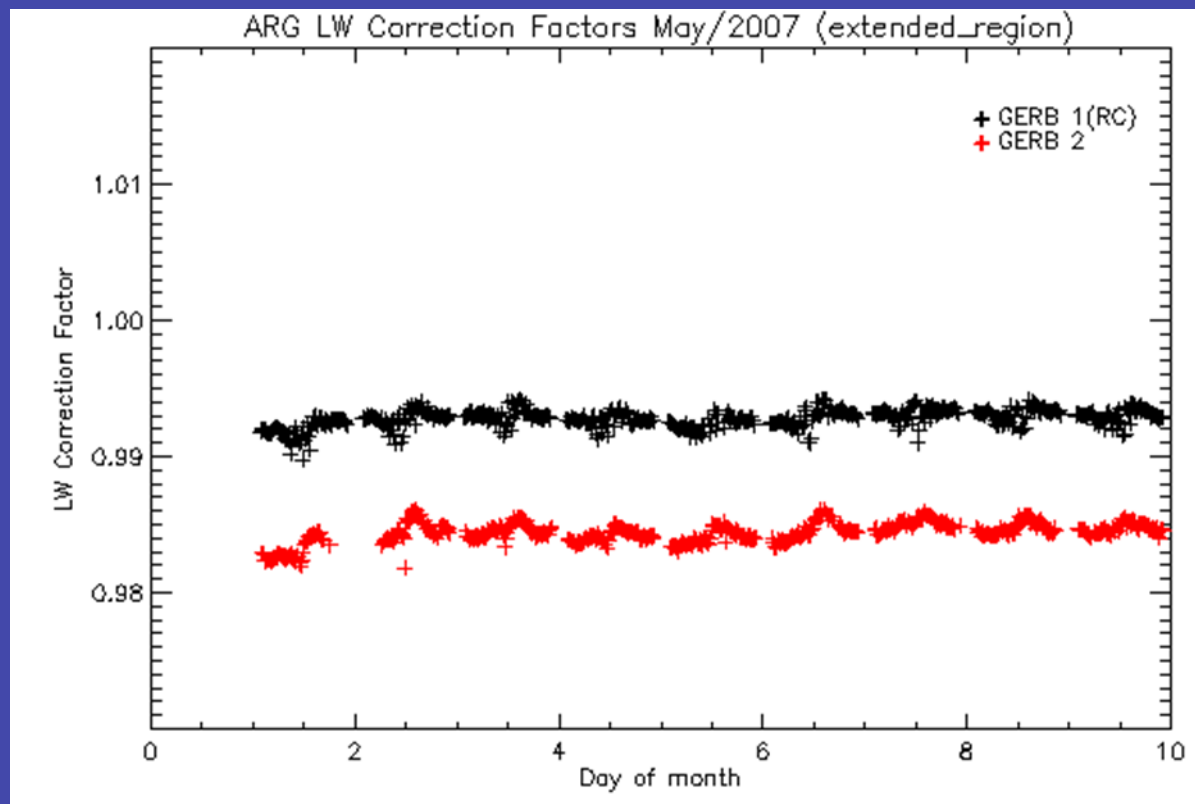


LW correction factors

# Updates: Calibration & Processing

- Calibration:
  - Quartz filter transmission for GERB 1 reduced by 1%
- Processing:
  - Inconsistency between cloud retrieval lookup tables for GERB1 -> incorrect scene ID -> incorrect radiance to flux conversion
  - Offline reprocessing of overlap data performed
  - Error in clear-sky reference image
- “Reprocessed & Corr.” GERB 1 data produced
- GERB 2 data remained unchanged

# ARG LW correction factors May '07



**Figure 2.5.3:** Area mean longwave correction factors for GERB-1 reprocessed corrected (RC) and GERB-2 Edition 1 data from February 2007. The mean values are calculated over the extended region (60°N/S, 60°E/W). Only those data points that exist for both GERB 1 and GERB 2 for a particular time are included in the calculation of the mean.



# Inter-comparison studies exploiting overlap data between GERB -1 & -2

Dates	GERB-1 (MSG-2) longitude (°E)	GERB-2 (MSG-1) longitude (°E)	CERES PAPS scan time and location
24/04/06 – 04/07/06 (01/06/06 - 30/06/06)	-6.65 to -6.35	-3.55 to -3.25	01/06/06 – 30/06/06 6.5 W (S Hemi)
19/07/06 – 17/08/06	+0.5 to +0.25	-3.55 to -3.45	N/A
09/01/07 – 10/02/07	+0.0 to +0.8	-3.6 to -3.45	19/01/07 – 10/02/07 1.75 W (N Hemi)
19/04/07 – 30/04/07	-0.4	-3.55	N/A
01/05/07 – 10/05/07	-0.4	-3.55	N/A

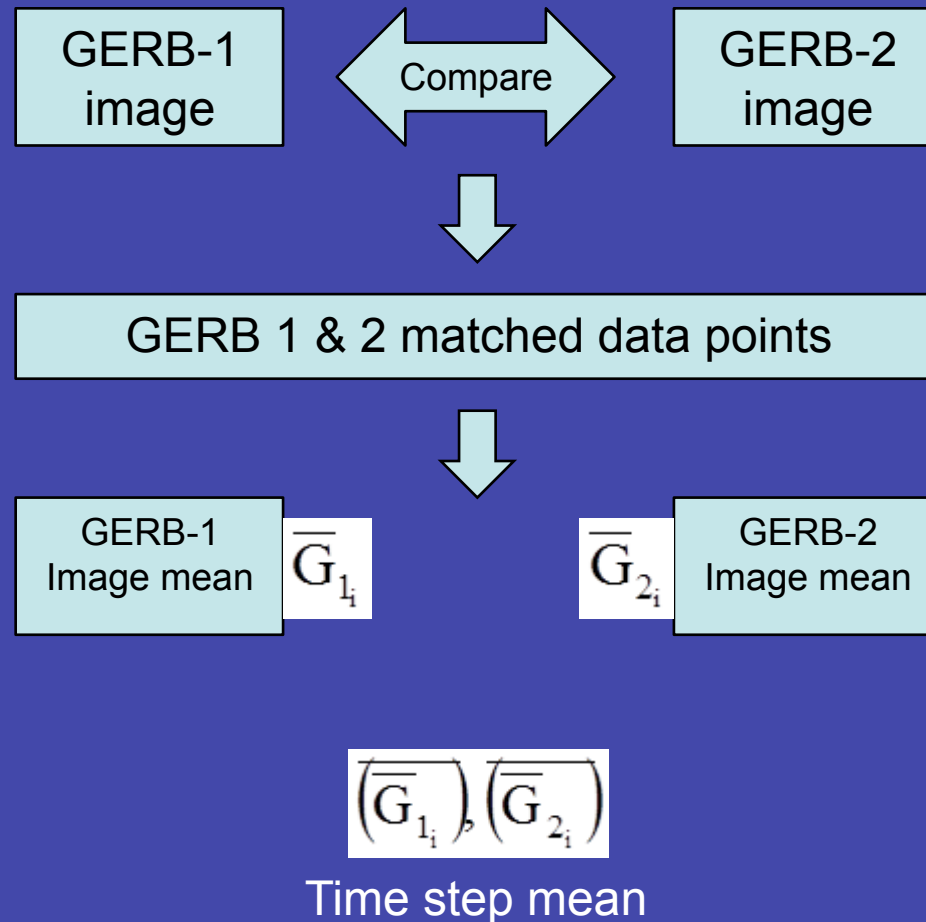


Data available latest version (reprocessed & corrected)

Data available for original processing only

Data unavailable

# Data matching method

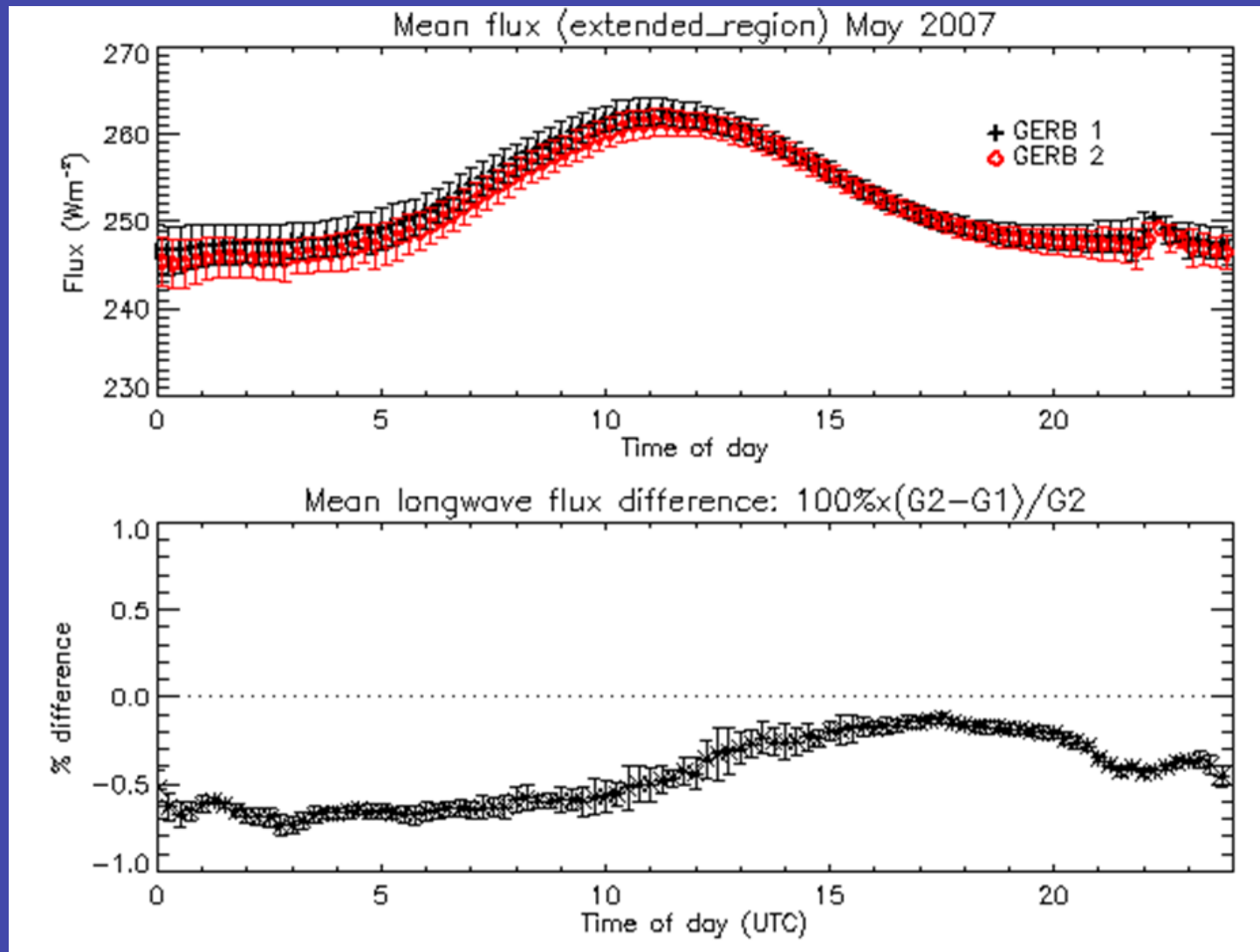


# L2 BARG LW

Binned Averaged Rectified Geolocated

- “Climate” product (unfiltered radiance, flux)
  - Regular grid (VZA), PSF removed
  - 45km resolution (at nadir)
  - 15 minute resolution
- 
- GERB 1 – Jan/Feb 2007: V005, May 2007: V006
  - GERB 2 – Jan/Feb/May 2007: V003

# L2 BARG LW Flux: Diurnal variation



“Extended region”:  $60^\circ\text{N/S}, 60^\circ\text{E/W}$

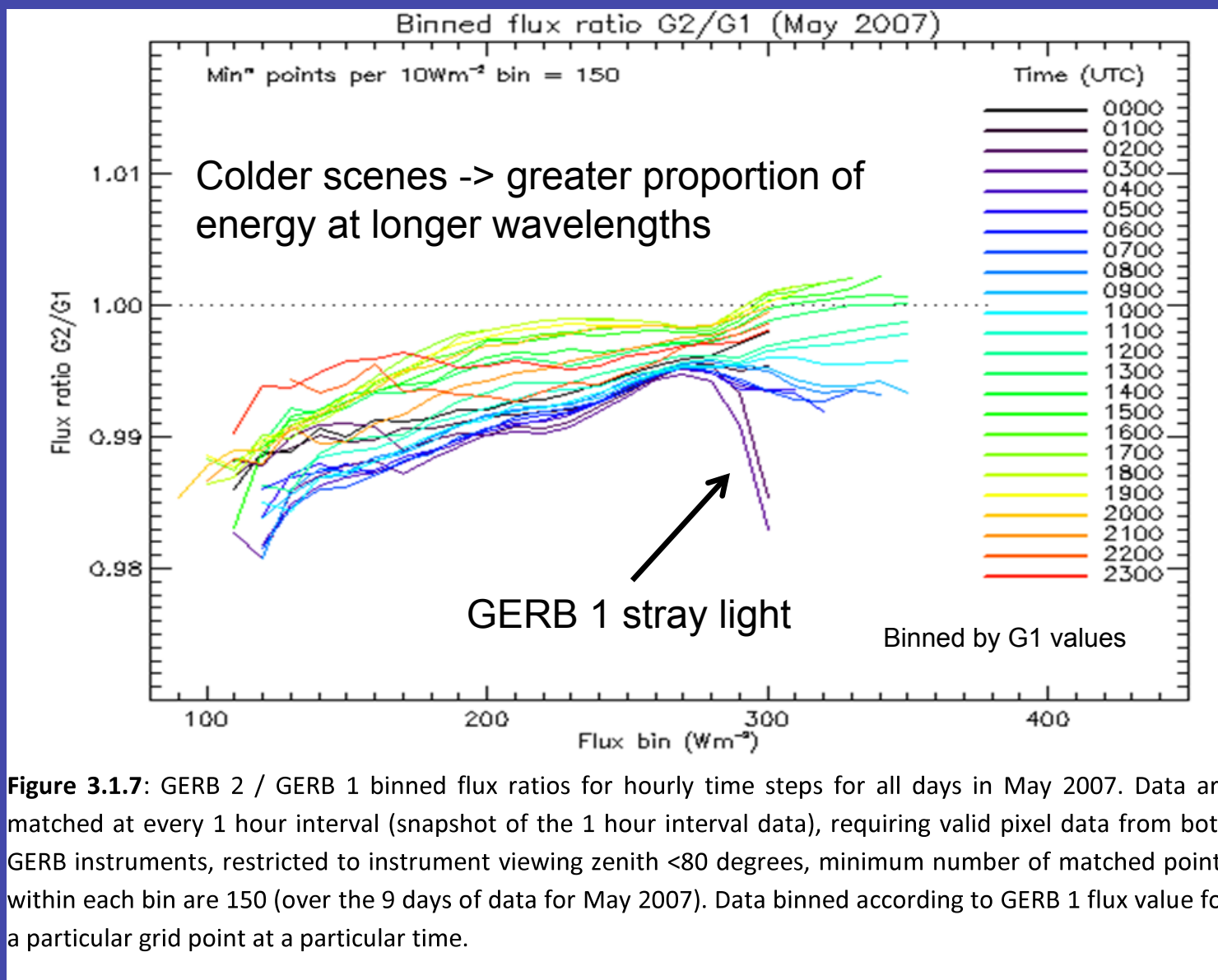
# L2 BARG LW Flux: Daily mean

GERB 1 > GERB 2

	GERB 1 LW Flux		GERB 2 LW Flux		100%x(G2-G1/G2)
	Mean (Wm <sup>-2</sup> )	Std. dev. (Wm <sup>-2</sup> )	Mean (Wm <sup>-2</sup> )	Std. dev. (Wm <sup>-2</sup> )	
<b>Jan 2007</b>	251.71	5.72	250.86	5.38	-0.34
<b>Feb 2007</b>	247.65	5.75	246.66	5.37	-0.40
<b>May 2007</b>	252.73	5.44	251.63	5.47	-0.44

**Table 3.1.1:** Daily mean flux calculated for January, February and May 2007. An area (60N/S, 60E/W) mean value was calculated for each 15 minute data interval for all days within the month where data existed for both GERB 1 and GERB 2. A monthly mean value for each 15 minute time interval was then computed, and finally a mean daily flux, and its associated standard deviation, was calculated from the 96 (15 minute) time intervals. The standard deviation is indicative of the mean 15 minute flux variability through the day.

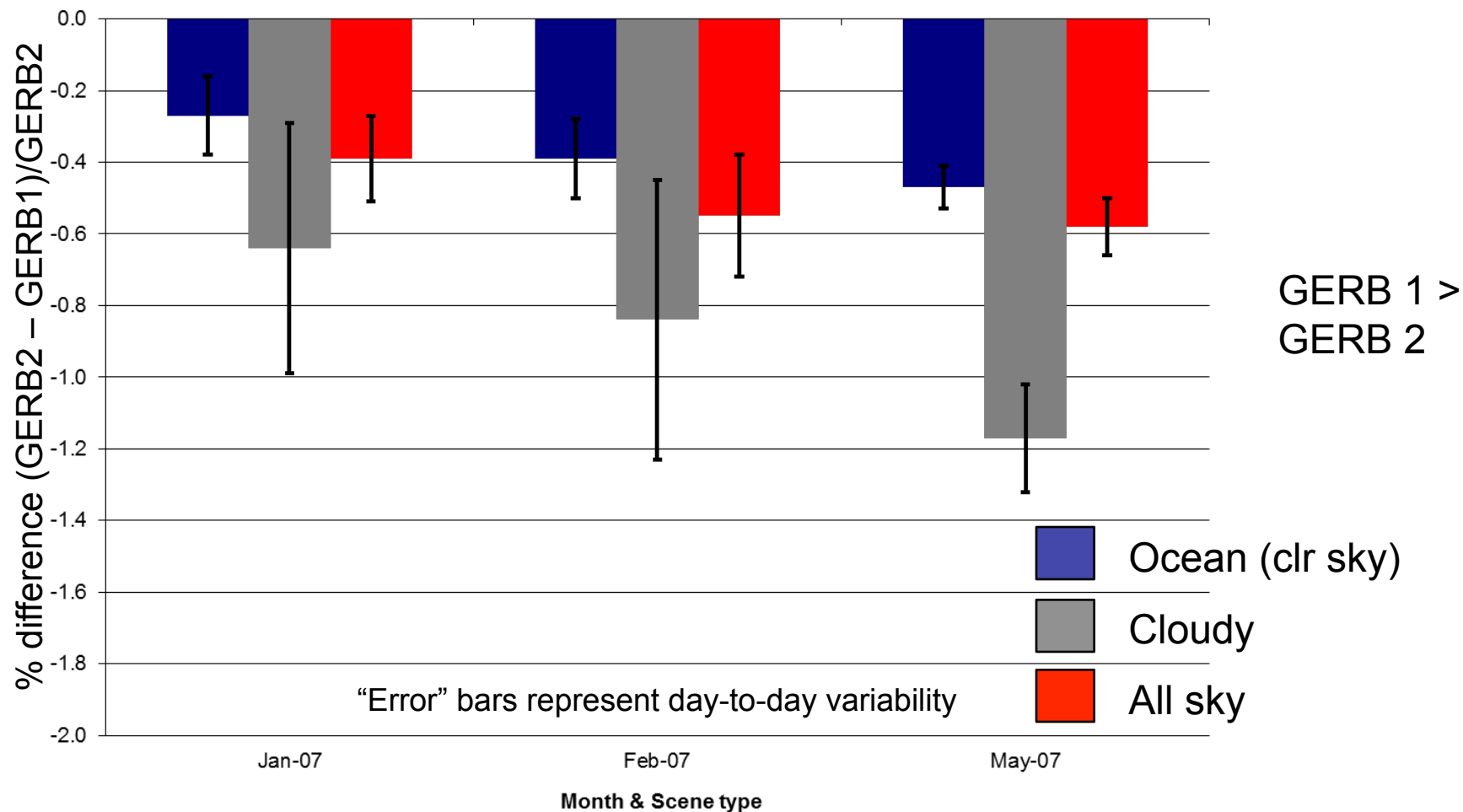
# L2 BARG LW Flux: Binned data



**Figure 3.1.7:** GERB 2 / GERB 1 binned flux ratios for hourly time steps for all days in May 2007. Data are matched at every 1 hour interval (snapshot of the 1 hour interval data), requiring valid pixel data from both GERB instruments, restricted to instrument viewing zenith <80 degrees, minimum number of matched points within each bin are 150 (over the 9 days of data for May 2007). Data binned according to GERB 1 flux value for a particular grid point at a particular time.

# L2 BARG LW Flux: Scene comparison

BARG LW flux scene comparison 2007 (12:00 UTC)

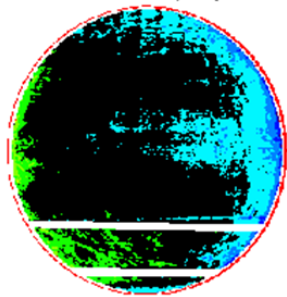


# L2 BARG LW Flux: Spatial comparison (6-hourly intervals)

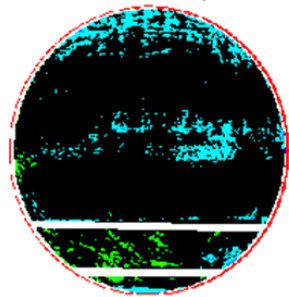
- Radiance: east / west variation
- Flux: east / west largely removed  
-> angular distribution models ok
- Flux residuals could be indication of spectral response differences for coldest scenes



mean radiance ratio G2/G1 (0000 UTC)

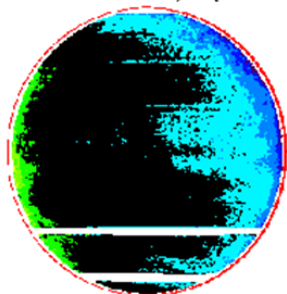


mean flux ratio G2/G1

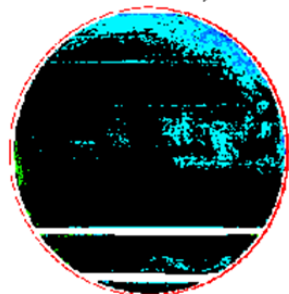


00:00 UTC

mean radiance ratio G2/G1 (0600 UTC)

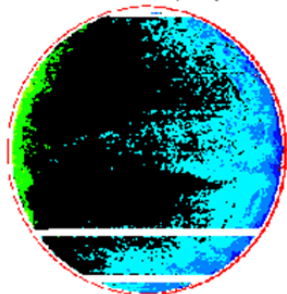


mean flux ratio G2/G1

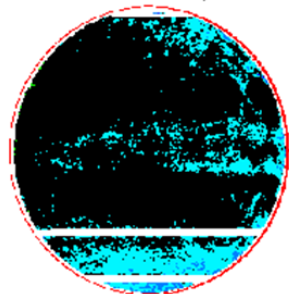


06:00 UTC

mean radiance ratio G2/G1 (1200 UTC)

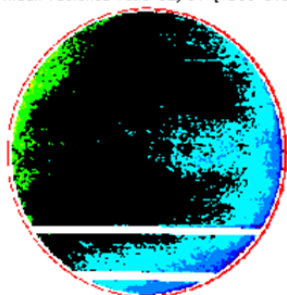


mean flux ratio G2/G1

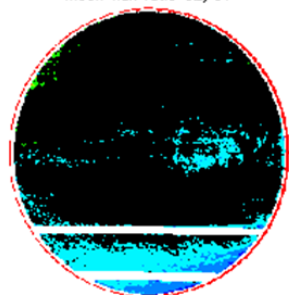


12:00 UTC

mean radiance ratio G2/G1 (1800 UTC)



mean flux ratio G2/G1



18:00 UTC



## Longwave Summary

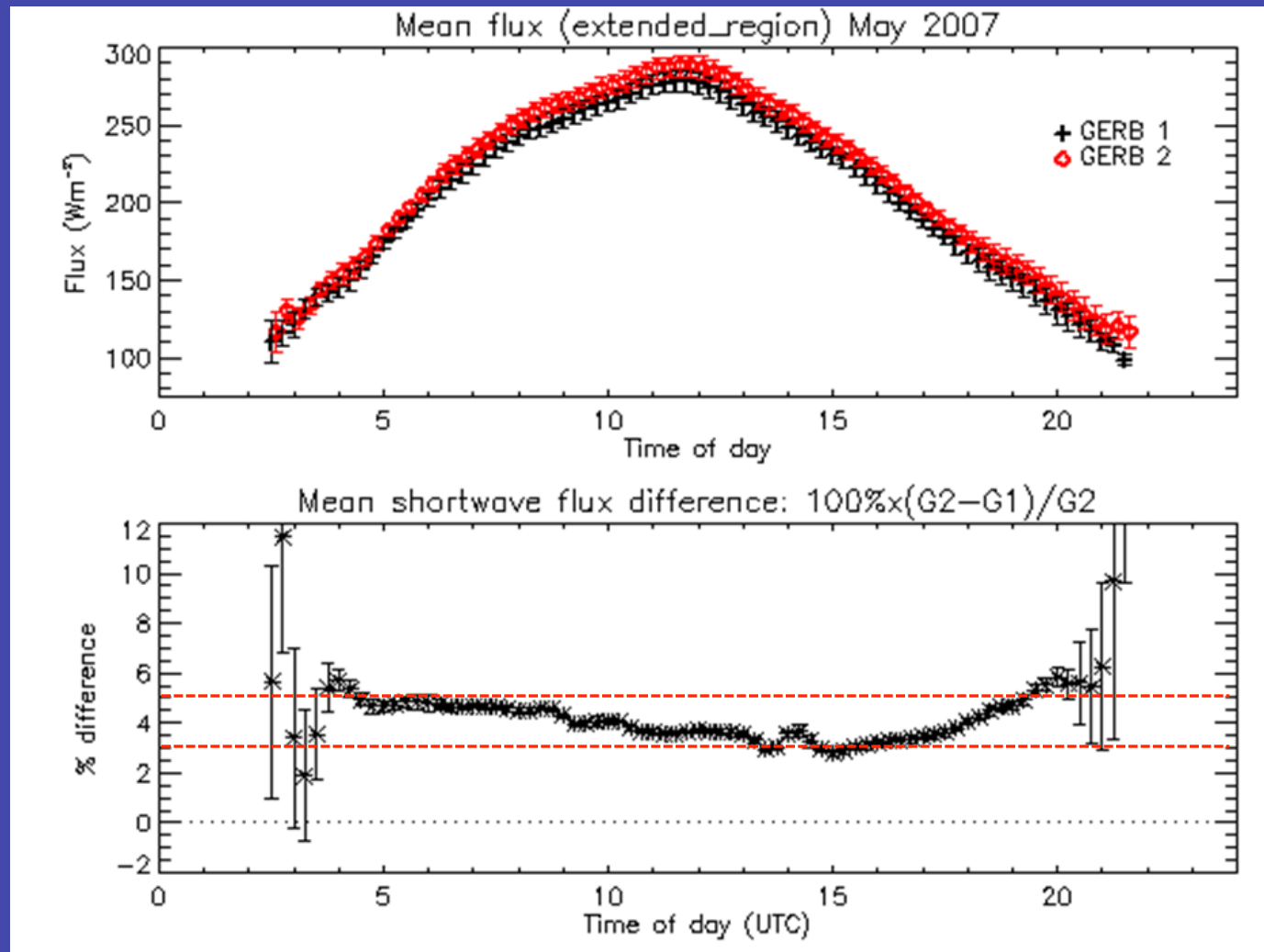
- On average, GERB 1 LW flux data are approximately  $0.4 \pm 0.04\%$  higher than GERB 2
- A diurnal variation in this offset of  $\pm 0.3\%$  is observed (min<sup>m</sup> and max<sup>m</sup> time varies with month)
- A scene dependence in the difference is observed:
  - Coldest scenes  $0.9 \pm 0.3\%$  GERB1 > GERB2
  - Clear ocean scenes  $0.38 \pm 0.09\%$  GERB1 > GERB2

# L2 BARG SW

Binned Averaged Rectified Geolocated

- “Climate” product (unfiltered radiance, flux)
  - Regular grid (VZA), PSF removed
  - 45km resolution (at nadir)
  - 15 minute resolution
- 
- GERB 1 – Jan/Feb 2007: V005, May 2007: V006
  - GERB 2 – Jan/Feb/May 2007: V003

# L2 BARG SW Flux: Diurnal variation



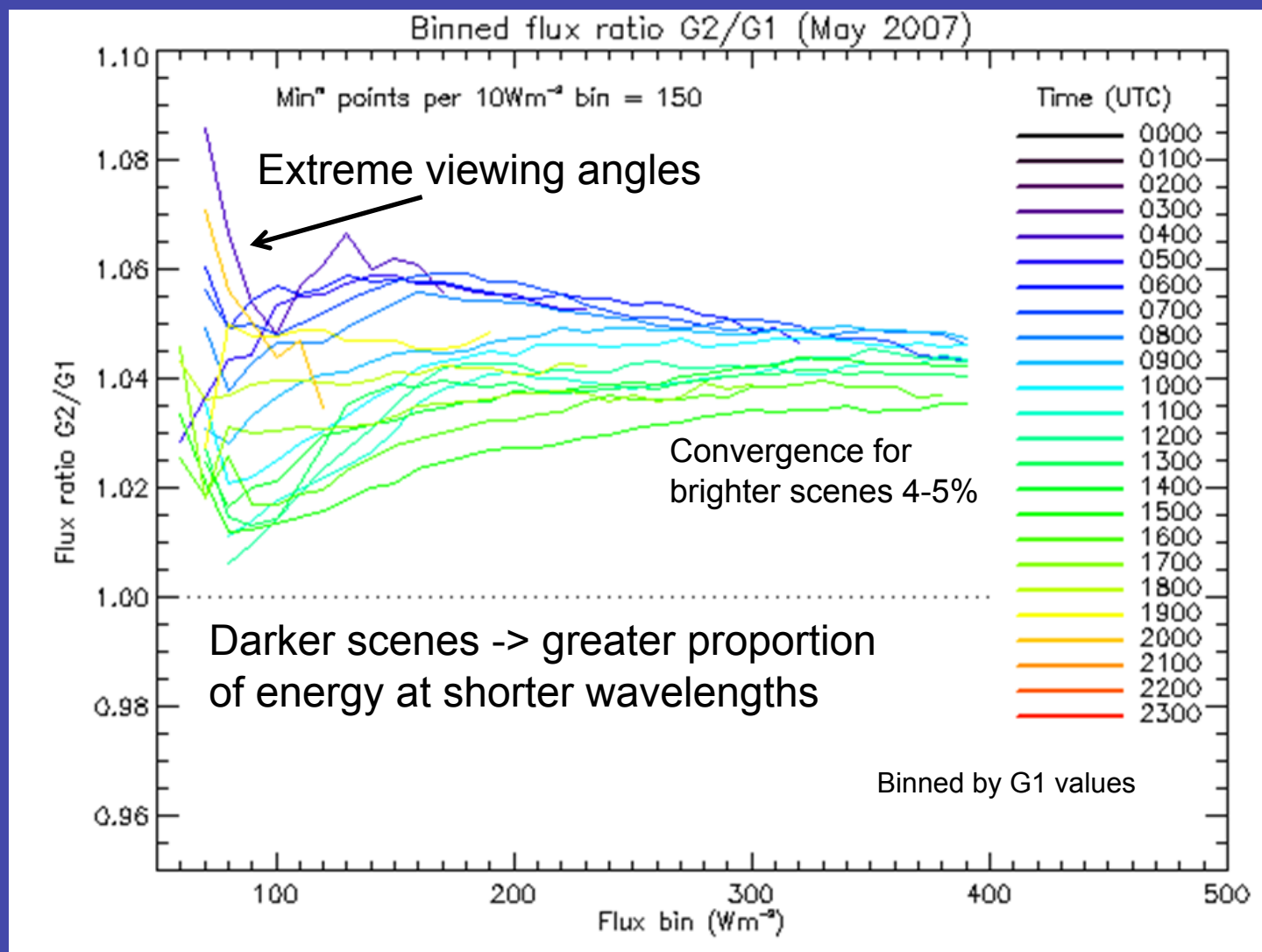
# L2 BARG SW Flux: Daily mean

GERB 1 < GERB 2

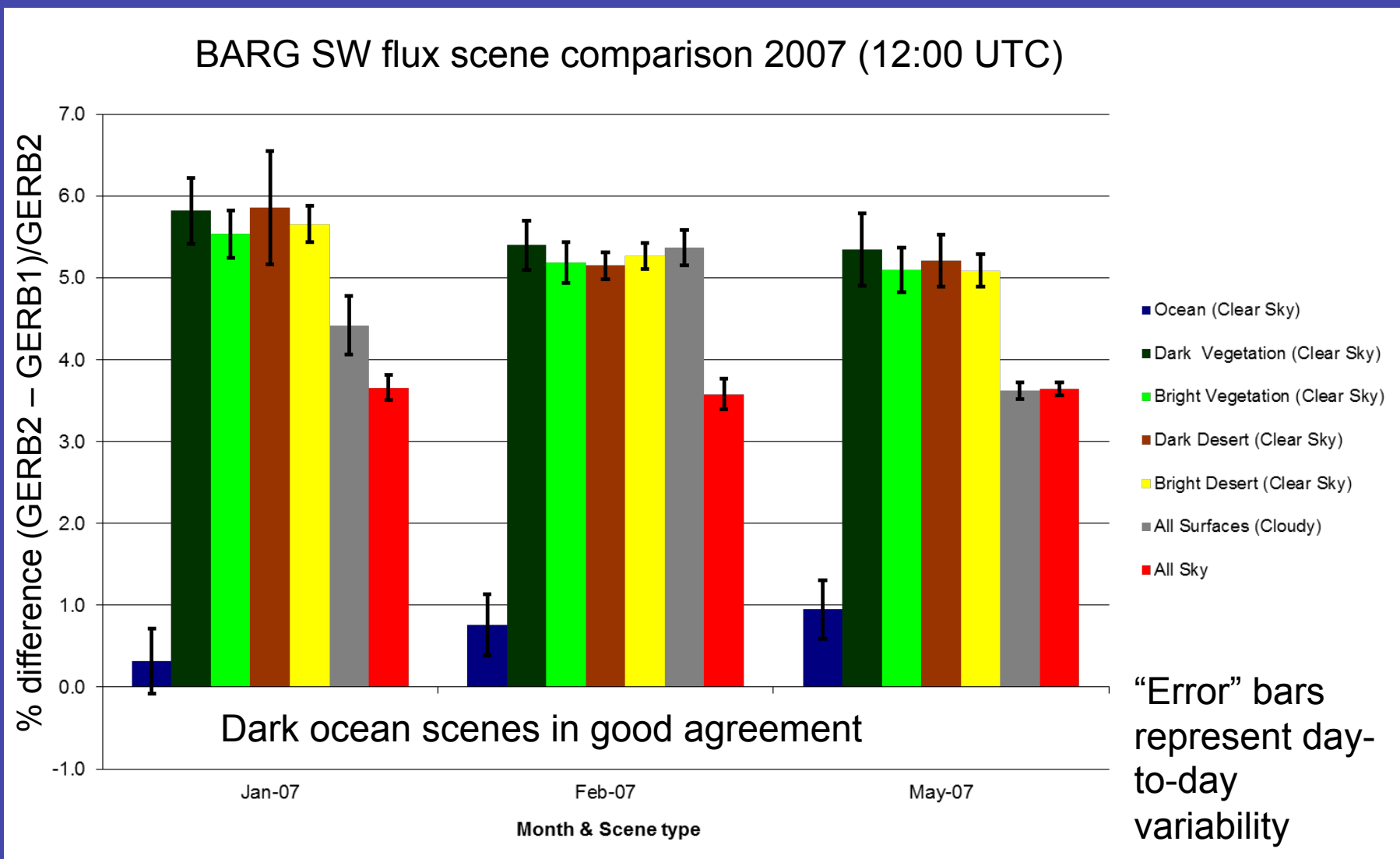
	GERB 1 SW Flux		GERB 2 SW Flux		100%x(G2-G1/G2)
	Mean (Wm <sup>-2</sup> )	Std (Wm <sup>-2</sup> )	Mean (Wm <sup>-2</sup> )	Std (Wm <sup>-2</sup> )	
<b>Jan 2007</b>	176.54	34.32	183.12	36.96	3.59
<b>Feb 2007</b>	190.02	45.36	197.64	47.86	3.86
<b>May 2007</b>	203.03	54.60	212.03	55.43	4.24

**Table 3.3.1:** Daily mean flux calculated for January, February and May 2007. An area (60N/S, 60E/W) mean value was calculated for each 15 minute data interval for all days within the month where data existed for both GERB 1 and GERB 2. A monthly mean value for each 15 minute time interval was then computed, and finally a mean daily flux, and its associated standard deviation, was calculated from all the valid (i.e. where SW data exists, so 0000UTC and others are excluded) 15 minute time intervals. The standard deviation is indicative of the mean 15 minute flux variability through the day and does not relate to the error on the mean.

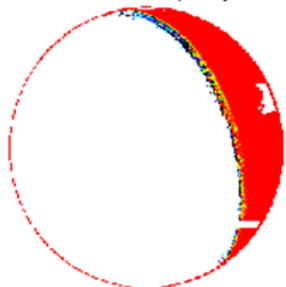
# L2 BARG SW Flux: Binned data



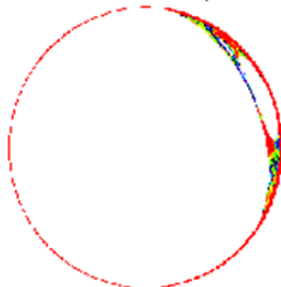
# L2 BARG SW Flux: Scene comparison



mean radiance ratio G2/G1 (0300 UTC)

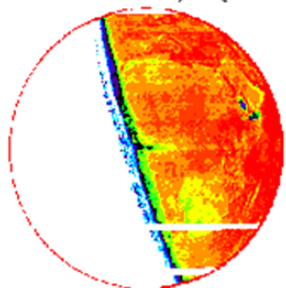


mean flux ratio G2/G1

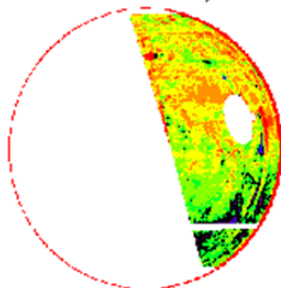


03:00 UTC

mean radiance ratio G2/G1 (0600 UTC)

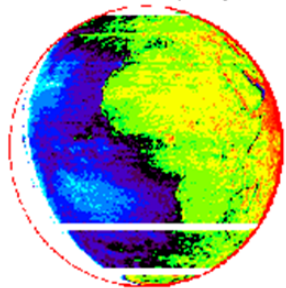


mean flux ratio G2/G1

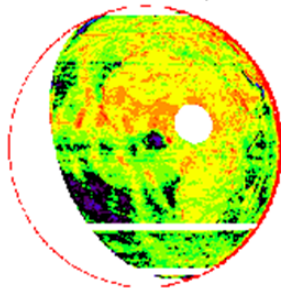


06:00 UTC

mean radiance ratio G2/G1 (0900 UTC)

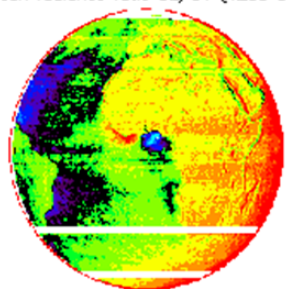


mean flux ratio G2/G1

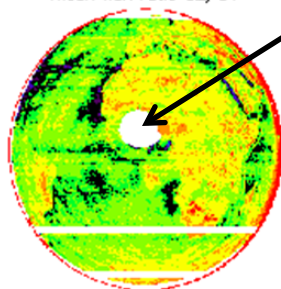


09:00 UTC

mean radiance ratio G2/G1 (1200 UTC)



mean flux ratio G2/G1



12:00 UTC

## L2 BARG SW Flux: Spatial comparison (3-hourly intervals)

- Radiances – east / west variation
- Fluxes – east west variation removed, offset remains
- Clearly, scene dependent offset remains

Sun glint



# Shortwave Summary

- All sky results indicate gross offset in SW BARG fluxes: GERB 1 is on average  $3.9 \pm 0.3\%$  < GERB 2
- Significant scene dependency observed:
  - Clear land:  $5.4 \pm 0.4\%$  GERB 1 < GERB 2
  - Clear ocean:  $0.6 \pm 0.3\%$  GERB 1 < GERB 2
  - Overcast: 3.6 to 5.4% GERB 1 < GERB 2
- Comparisons between GERB 1 and GERB 2 level 0 data indicate a potential ground calibration problem. Investigation into this is on-going, but to-date, NPL have already revised SW abs. calibration of visible source -> reduce G2 by 2.5-3.5% for all scenes
- Independent validation studies suggest GERB 2 spectral response altered during lifetime (darkening at shortest wavelengths).



# Conclusions & Recommendations (1)

- Users of GERB data will be made aware that the swap from G2->G1 on 1<sup>st</sup> May 2007, results in a jump in the LW and SW flux records.
- These jumps will remain in Edition 1 record, but we hope this study will enable a consistent dataset to be produced in the future.
- At present, users should allow for ~0.4% increase to the GERB LW flux, and ~ 4% reduction in the SW, but be aware of scene dependency.

## Conclusions & Recommendations (2)

- Users will be advised to apply the following multiplication factors, for gross adjustment:
  - GERB 1 LW Flux by 0.996
  - GERB 1 SW Flux by 1.05 (all scenes except ocean)
- Users should note that new (current) knowledge suggests GERB 2 SW will be lowered by 2.5% in future Editions.
- Some evidence for spectrally dependent darkening throughout lifetime of GERB 2 optics for bluest scenes. Investigations on-going.
- Full x-cal document: MSG-ICL-GE-RP-0036

# Extras

# GERB – CERES Comparisons

- Series of comparisons between GERBs & CERES, considering matched radiance and flux
- GERB-CERES comparisons are in general agreement with GERB-GERB comparisons:
  - LW: good agreement (within 1%)
  - SW: GERB 1 radiances excellent agreement (all sky)  
GERB 2 radiances several (3-4%) higher  
GERB 1 flux 1-1.5% increase (all sky)  
GERB 2 flux (offset) + 1-1.5% increase (4.5%)
- SW land scene comparisons indicate potential issue with ADM